

## Constrained Growth

To model constrained growth, you will build a population dynamics models for predator and prey which includes part of the interactions conceptualized under this topic. The interactions are based on a model formulated by an American demographer Alfred Lotka and an Italian physicist name Vito Volterra working independently.

The model expressed as a difference equation for rabbits and wolves like in our examples is:

$$\text{Rabbit population}(t+1) = \text{Rabbits}(t) * \text{Rabbit Growth Rate} - \text{Rabbits}(t) * \text{Rabbit Death Rate} * \text{Wolves}(t)$$

$$\text{Wolf Population}(t+1) = \text{Wolves}(t) * \text{Wolf Growth Rate} * \text{Rabbits}(t) - \text{Wolves}(t) * \text{Wolf Death Rate}$$

Where  $t$  is the time increment.

If we start with the basic growth model from interest and instead calculate rabbits, the only information we need it the rabbit growth and death rates and the initial number of wolves to satisfy the first equation. Similarly, we can use the basic growth rate model to model the wolf population needing only the wolf birth and death rates and the initial rabbit population.

Create a model that incorporates these new factors and plot the population of rabbits and wolves on the same graph over time.

Here are the parameters you should use to start. If your model works correctly, you should observe a cyclical pattern where the prey increases followed by an increase in predators and then a decline in both.

Parameter	Rabbits	Wolves
Growth Rate	0.1	.005
Initial population	40	15
Death Rate	0.01	0.1
Time period	200	200

You should notice that the pattern that emerges is becoming increasingly unstable, with larger peaks and valleys. Discuss how this model could be modified to make more like the conceptual model of rabbits and foxes presented in this topic in a way that would ameliorate those extremes and more closely affect the forecasted outcomes. What components would you need to add and what data would you need to provide the appropriate rates and constants? Discuss the findings of your model along with those concerning the design of the more complex model.